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PROCESSING OF ACTINOMETRIC DATA BY THE "COSMOS-122" SATELLITE

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Different types of actinometric measurements, performed by the "Cosmos-122" satellite, are listed. The theory of devising a computerized program, and the program itself, as employed to process actinometric data, collected by the "Cosmos-122" satellite, are detailed. Specimen outputs in the form of charts and graphs are shown and described.

3 illustrations, 4 references.

Meteorological information, obtained from satellites, can be separated /47* into two categories, depending on the processing methods. The first category includes television and infrared information which is processed manually by qualitative decoding of the cloud images. The second category includes actinometric data, which contains information on the temperature and the radiation intensity in different spectral intervals; this type of information is processed by electronic computers.

Undoubtedly, in the future, all types of information will be processed by electronic computers. To resolve this problem, however, it will be necessary to develop new algorithms and to improve the computers, especially with a view to expanding the capacitances of their memories.

The advantages of machine processing are that it is possible to use objective methods of information diagnosis in order to obtain reliable data, interpretations. At the present time, the principal difficulty, facing the

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* Numbers in the margin indicate the pagination in the original foreign text.

automation problem, is the development of objective analytical methods of satellite data analysis on the cloudiness.

Computer data processing imposes a number of requirements on the on-board satellite instrumentation and on the means by which the data, obtained from the instrumentation complex, are processed.

A number of studies are presently available that deal with the implementation of automated processing of meteorological satellite data [4]. In an experiment with the "Cosmos-122" satellite, we tested automatic processing methods of actinometric data, immediately following the contact period with the satellite [3].

The development of this system required a tie-in of the entire information circuit, from the moment information was received by the input station and until the processed information was released on the connecting circuit for its dissemination. Naturally, a number of faults were discovered during the first attempt to implement this type of system. Theoretically, however, it was justified, and a number of improvements were planned; it is anticipated that in the future these improvements will contribute to a greater efficiency of the system.

The actinometric instrumentation of the "Cosmos-122" satellite consisted of narrow-sector and wide-sector devices; these devices were used to perform the following measurements:

a) Outgoing radiation in the 8 - 12 micron spectrum;
b) Outgoing radiation in the 3 - 30 micron spectrum;
c) Reflected solar radiation in the 0.3 - 3.0 micron spectrum. /48

The narrow-sector devices were used to perform the measurements in all the indicated intervals, using an angular resolution of $5x5^{o}$. The optical axes of these devices were oscillating (scanning) in a plane, that was perpendicular to the plane of the satellite's orbit, thus providing the data within the limits of $\pm 60^{\circ}$ of the nadir bearing direction.

Using the measurements of the scanning actinometric transducer in the 8 - 12 micron region, it is possible to determine the radiation temperature of the underlying surface. Narrow-sector instrumentation data in the 3 - 30 and 0.3 - 3.0 micron range can be used for radiation balance analysis in the earth-atmosphere system, as well as for a more precise projection of the position of large-scale cloud systems.

To measure the radiation balance components of the earth-atmosphere system on a planetary scale, the "Cosmos-122" satellite was equipped with wide-sector scanning devices. The angle of vision of these devices covered the entire disk of the earth, as visible from the satellite. The wide-sector devices provided for a measurement of the radiation fluxes in spectral intervals of 0.3 - 3.00 and 3 - 30 microns.

During the flight, the equipment was regularly standardized in order to check the validity of its calibration data. While the "Cosmos-122" satellite was functioning, these data did not undergo any appreciable changes.

The operative processing system for the "Cosmos-122" information was designed around an electronic computer; the input components of this computer lend themselves to a rewrite of the information, received during the contact with the satellite, on magnetic bands. The basic output element of the computer is an alphanumerical printing assembly.

After the on-board information, received from the satellite, is transcribed on the computer's magnetic bands, the subsequent processing of this information takes place according to a predetermined and specially-designed program.

This program provides for:

1) Control and rejection of erroneous data;

2) Selection of the narrow-sector scanning rows from the total information complex;

3) Referencing the entire amount of information to time. This is performed by the program block which selects the coded time groups transmitted from the satellite, controls their reliability, and determines the time of the initial measurement in each row;

4) Selection of additional data, required for the processing of the measurements;

5) Keying each individual measurement to a geographic map;

6) A recalculation of the electrical signals into physical magnitudes (radiation temperature and radiation intensity), using conversion tables;

7) Output of data, in the form of matrix-charts and tables.

The actinometric information, obtained by the "Cosmos-122" satellite, was processed in stages. At each processing stage, the calculations were performed for the entire amount of information received during the communication period with the satellite.

The program of each stage, recorded in a specially-designed magnetic band section of the computer, is recalled into the operative memory prior to the beginning of the current calculation state. The calculation results, performed at each stage, are recorded on the magnetic band of the computer and read into the operating memory, to serve as initial data during subsequent processing stages.

A processing program thus designed provides for a performance of the computations at each processing stage, regardless of the computations performed at previous stages. When the correctness of the computations at any /49 given stage is violated, the calculations can be repeated using the initial

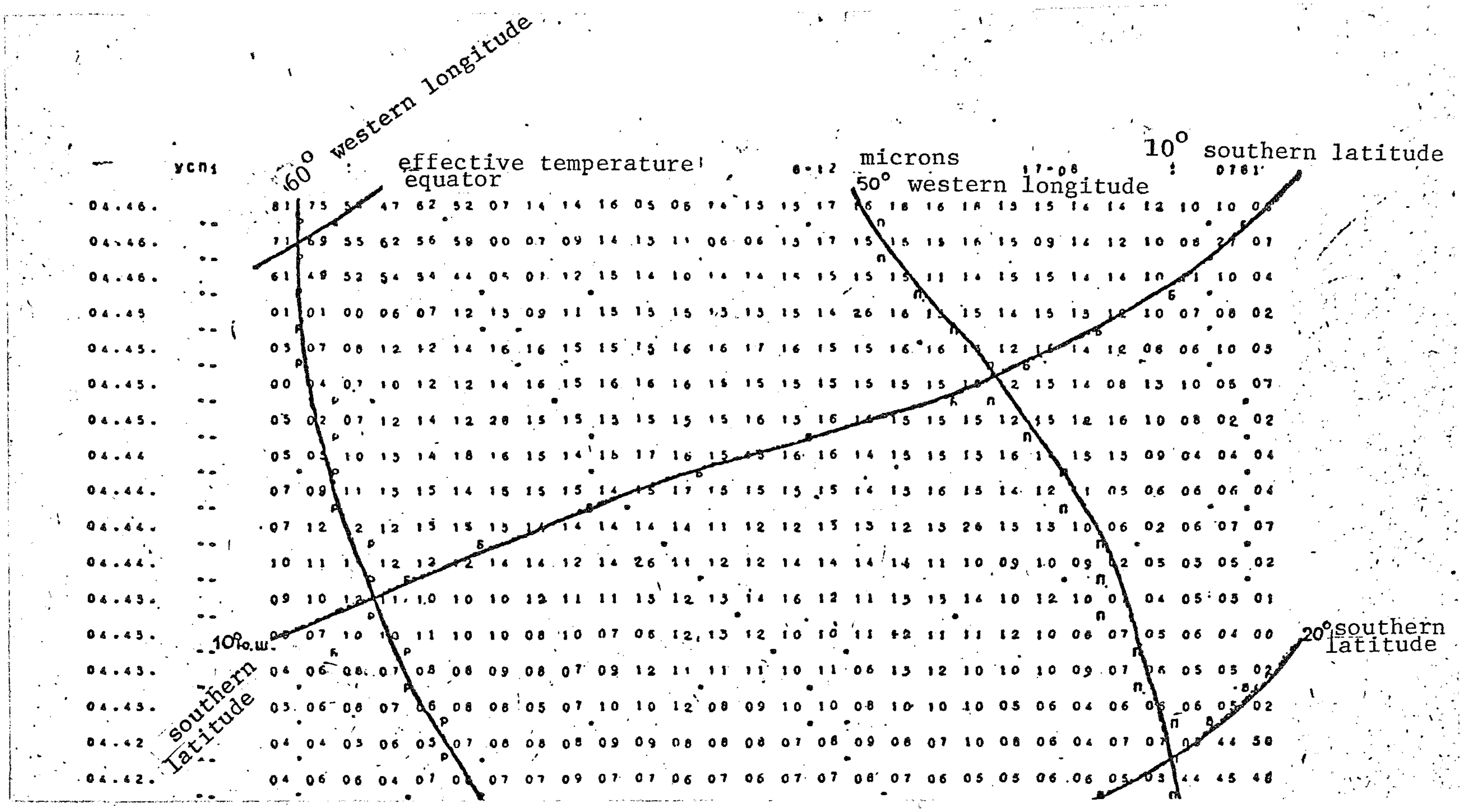

Figure 1. Chart-matrix of the 8 - 12 microns channel in terms of effective (radiation) temperature, taken by the "Cosmos-122" satellite, on 17 August 1966 during the 781st revolution. The factor of 40° is added to negative temperatures.

(Figure 1 is continued on the next page.)

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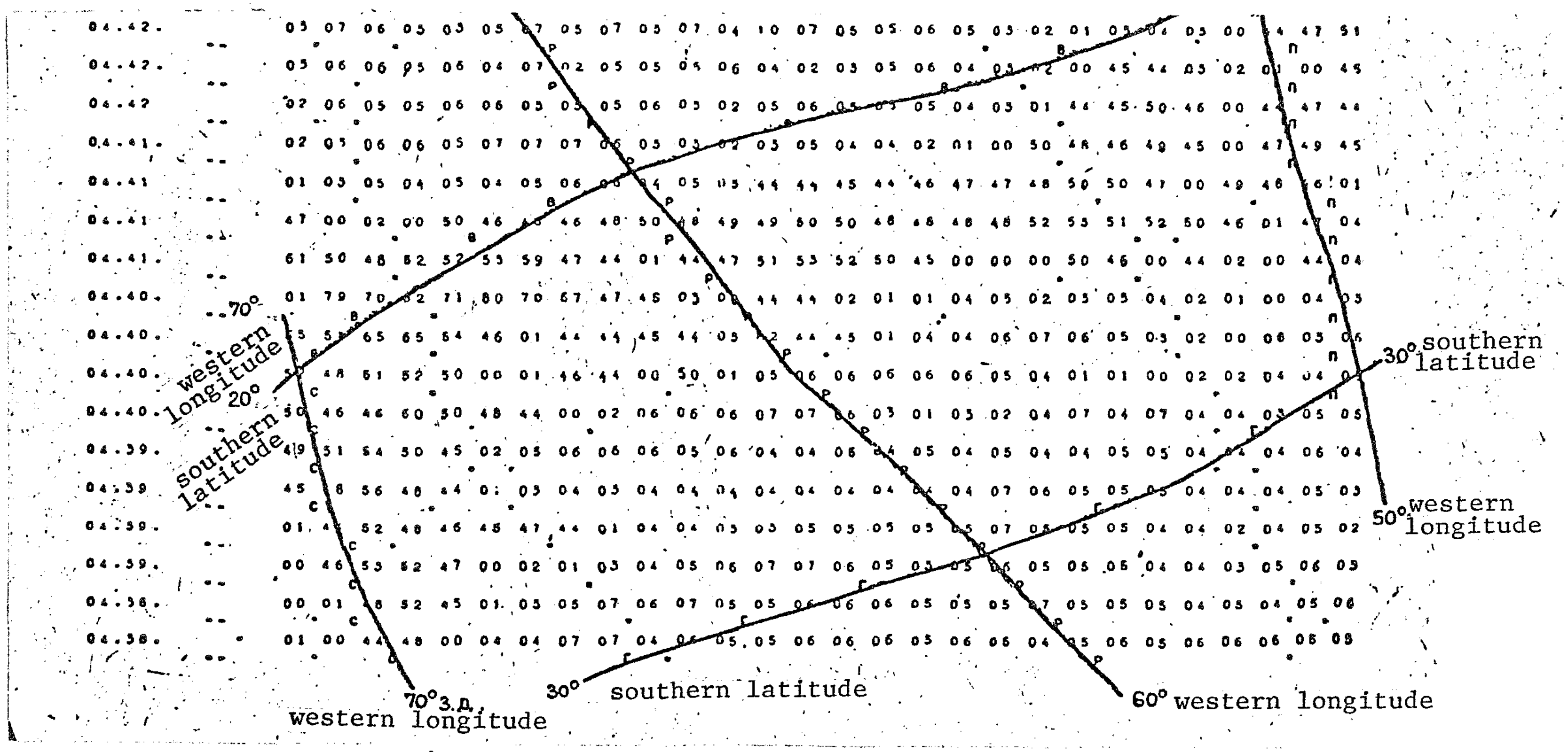

Figure 1 (cont'd). Chart-matrix of the 8 - 12 microns channel in terms of effective (radiation) temperature, taken by the "Cosmos-122" satellite, on 17 August 1966 during the 781st revolution. The factor of 40° is added to negative temperatures.

data retained on the magnetic band after the preceding processing stage.

Wide-sector measurement data were processed manually, in view of the small amount of them and the necessity of analyzing the obtained data with extreme care [1].

The processing results of actinometric data are put out by the computer in the form of card-matrixes that include a grid of geographic coordinates. An algorithm of this program was detailed in [2]. The geographic grid is

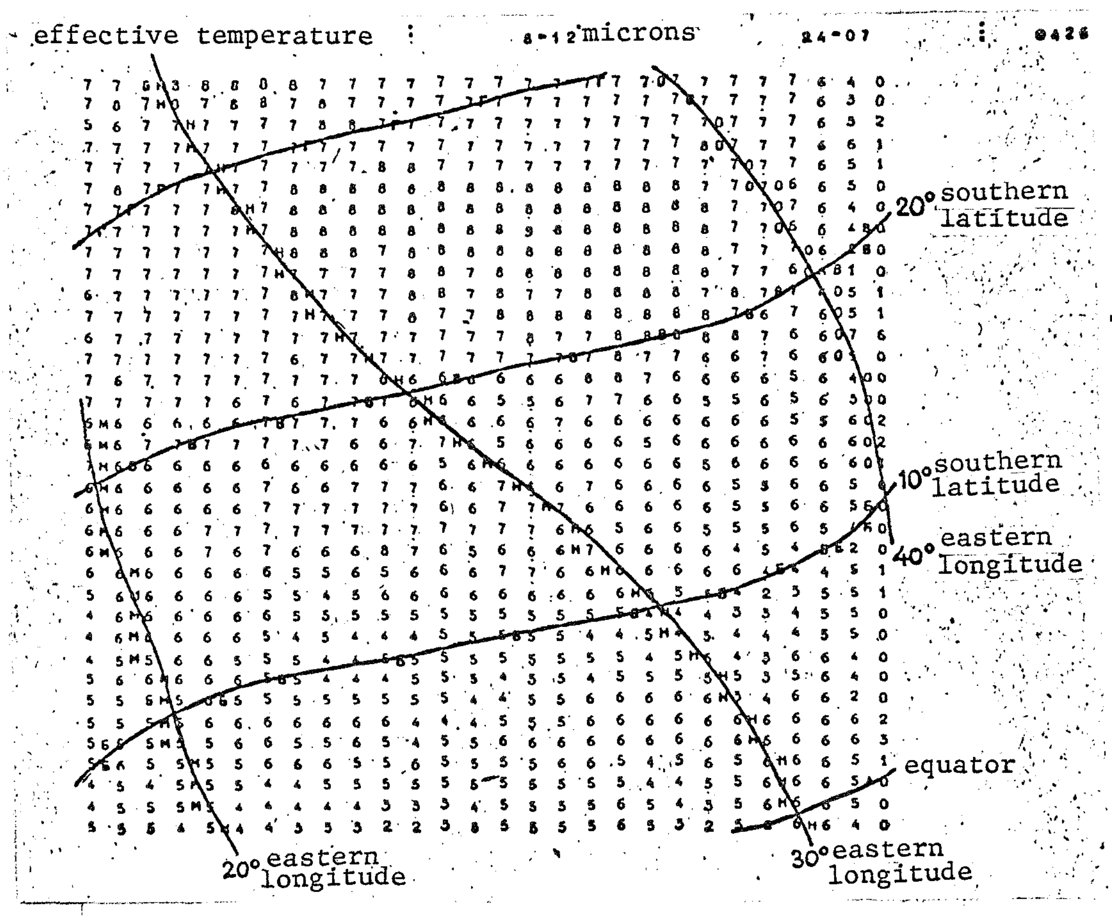

Figure 2. Chart showing the measurements of the 3 - 30 microns channel in terms of graduated radiation intensity (satellite "Cosmos-122", 426th revolution, 24 July, 1966).

displayed in the form of letters (Russian alphabet), denoting the latitudes (from A to Й) and the longitudes (from K to Я) in multiples of 10°. The operator that processes the actinometric information draws the arcs of the parallels and of the meridians, using these notations, and numbers them. The parallels and the meridians, that are multiples of 5, are identified on the chart by special symbols. The Moscow time of the first measurement in hours and minutes is printed in-line on the left edge of the chart-matrix. This is followed by a column of signs of the geographic grid ("+" for northern latitude and eastern longitudes, taken for the closest measurement (first sign for latitude, the second for the longitude).

The heading of each chart indicates the date and the satellite revolution number (Figure 1), the spectral interval, as well as the units in which the charted magnitude is measured. /50

Since the values, that are put into the printout are not averaged, it is possible to compare them with terrestrial data, and also to process them further. A geographic coordinate grid, superimposed upon the chart, controls the position of each measurement and contributes to checking the correctness of the program in an operative sequence.

The results of the processing, performed according to the methods described in [4], are used to obtain a more compact chart which, in turn, is used to prepare the materials that are distributed in an operational sequence (Figure 2). With this output method, the range of the measured magnitude is divided into 20 intervals. The magnitudes of the measurements, relevant to each interval, are printed on the chart-matrix in the form of special symbols.

The actinometric data processing system of the information provided by the "Cosmos-122" satellite was checked in actual operation. At the present time, the system is being perfected, taking into account the accumulated experience.

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